Total Ozone Mapping Spectrometer measurements of aerosol absorption from space: Comparison to SAFARI 2000 ground-based observations

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[1] The capability to detect the presence of absorbing aerosols in the atmosphere using space-based near-UV observations has been demonstrated in the last few years, as indicated by the widespread use by the atmospheric sciences community of the Total Ozone Mapping Spectrometer (TOMS) aerosol index as a qualitative representation of aerosol absorption. An inversion procedure has been developed to convert the unique spectral signature generated by the interaction of molecular scattering and particle absorption into a quantitative measure of aerosol absorption. In this work we evaluate the accuracy of the near-UV method of aerosol absorption sensing by means of a comparison of TOMS retrieved aerosol single scattering albedo and extinction optical depth to ground-based measurements of the same parameters by the Aerosol Robotic Network (AERONET) for a 2-month period during the SAFARI 2000 campaign. The availability of collocated AERONET observations of aerosol properties, as well as Micropulse Lidar Network measurements of the aerosol vertical distribution, offered a rare opportunity for the evaluation of the uncertainty associated with the height of the absorbing aerosol layer in the TOMS aerosol retrieval algorithm. Results of the comparative analysis indicate that in the absence of explicit information on the vertical distribution of the aerosols, the standard TOMS algorithm assumption yields, in most cases, reasonable agreement of aerosol optical depth (±30%) and single scattering albedo (±0.03) with the AERONET observations. When information on the aerosol vertical distribution is available, the accuracy of the retrieved parameters improves significantly in those cases when the actual aerosol profile is markedly different from the idealized algorithmic assumption.

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1. Introduction

[2] The role of atmospheric aerosols in the global climate is one of the largest remaining sources of uncertainty in the assessment of global climate change. Aerosols directly affect the energy balance of the Earth-atmosphere system, through the processes of scattering of solar radiation, which redistributes the incoming solar energy in the atmosphere, and absorption (of both solar and infrared radiation), which transforms radiative energy into internal energy of the absorbing particles and heats up the atmosphere. In addition, aerosols, through their role as cloud condensation nuclei, have an indirect effect on climate by affecting the albedo and lifetime of clouds [*Haywood and Boucher*, 2000].

[3] The cooling effect of aerosols, associated with the backscattering to space of a fraction of the incoming solar energy, is considered to be a very important counteracting factor of the well known warming effect of the greenhouse gases. The absorption by aerosol particles of a fraction of the incident sunlight and, for certain aerosol types, infrared radiation, results in a heating of the atmosphere. Thus aerosol absorption reduces the cooling effect commonly associated with aerosol particles. Although, the impact of aerosol absorption on climate is still a subject of considerable debate [*Penner et al.*, 2003], recently published theoretical analysis suggest that black carbon may be the second most important global warming substance (in terms of its direct radiative forcing effect) after carbon dioxide, and larger than methane [*Jacobson*, 2002]. The role of aerosol absorption effects on climate is, therefore, an issue that needs to be better understood in order to reduce the currently large uncertainties of its climatic effect.

[4] In this paper, we present and discuss the results of the application of the near-UV method to observations by

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